CLAIMS

What is claimed is:

1. An apparatus for switching electrical current, comprising:

a) an ohmically isolated island comprised of material having a band gap, wherein the island is sufficiently large such that electron energy levels within the island are separated by less than 100 meV;

b) a source contact;

c) a first tunnel junction barrier disposed between the island and the source contact, wherein the first tunnel junction barrier has a thickness and cross sectional area selected such that a first tunnel junction formed by the source contact, the first tunnel junction barrier and the island has a resistance less than a quantum resistance;

d) a drain contact;

e) a second tunnel junction barrier disposed between the island and the drain contact, wherein the second tunnel junction barrier has a thickness and cross sectional area selected such that a second tunnel junction formed by the drain contact, the second tunnel junction barrier and the island has a resistance less than the quantum resistance;

f) a gate electrode capacitively coupled to the island.

2. The apparatus of claim 1 wherein the island comprises semiconductor material selected from the group consisting of silicon and germanium.

3. The apparatus of claim 1 wherein the first tunnel junction and second tunnel junction each have resistances less than 10 KOhms.

4. The apparatus of claim 1 wherein the first tunnel junction and second tunnel junction each have resistances less than 1 KOhms.

5. The apparatus of claim 1 wherein the first tunnel junction and second tunnel junction each have resistances less than 100 Ohms.

6. The apparatus of claim 1 wherein the first tunnel junction barrier and second tunnel junction barrier each have a thickness less than 24 Angstroms and a cross sectional area greater than 0.04 microns^2.

7. The apparatus of claim 1 wherein the first tunnel junction barrier and second tunnel junction barrier each have a thickness less than 18 Angstroms and a cross sectional area greater than 0.01 microns^2.

8. The apparatus of claim 1 wherein the first tunnel junction barrier and second tunnel junction barrier each have a thickness less than 12 Angstroms and a cross sectional area greater than 0.0025 microns^2.

9. The apparatus of claim 1 wherein the first and second tunnel junction barriers comprise insulator material selected from the group consisting of silicon oxide and aluminum oxide

10. The apparatus of claim 1 further comprising a gate insulating layer disposed between the gate electrode and the island.

11. The apparatus of claim 10 wherein a channel length between the first tunnel junction and second tunnel junction is in the range of 0.02-0.2 microns.

12. A circuit, comprising:

a pair of tunnel junctions, each having a resistance less than or equal to approximately a quantum resistance, separated by an island formed of a material having a non-uniform density of energy states, each of the tunnel junctions being formed by the interconnection of the island with a respective one of a pair of conductors through a tunnel junction barrier; and

a gate electrode capacitively coupled to the island.

13. The circuit of claim 12 wherein the island is formed of a superconductor material.

14. The circuit of claim 12 wherein the island is formed of a semiconductor material.

15. The circuit of claim 14 wherein the semiconductor material comprises silicon.

16. The circuit of claim 14 wherein the semiconductor material comprises germanium.

17. The circuit of claim 12 wherein the tunnel junction barriers are formed of an oxide of a material from which the conductors are made.

18. The circuit of claim 17 wherein the gate electrode is made of the same material as the conductors.

19. The circuit of claim 12 wherein the tunnel junction barriers are formed of an oxide of a material from which the island is made.

20. The circuit of claim 12 wherein the tunnel junction barriers are formed of a material different from that of which the island is made and different from that of which the conductors are made.

21. The circuit of claim 12 wherein the island is formed of an undoped material.

22. The circuit of claim 12 wherein the non-uniform density of energy states comprises at least one region that contains available energy states adjacent to at least one region that does not contain any available energy states.

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23. A method, comprising forming a conduction path between a pair of tunnel junctions each having a resistance less than or equal to approximately a quantum resistance by shifting energy states of an island formed of a material having a non-uniform density of such energy states, the island being disposed between the tunnel junctions.

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24. The method of claim 23 wherein the energy states of the island are shifted by application or removal of a voltage through an electrode capacitively coupled to the island.

25. The method of claim 24 further comprising passing a current through the conduction path via electrodes coupled to the tunnel junctions.